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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 4 : B60C 21/10

A1

(11) International Publication Number: WO 88/ 06539

(43) International Publication Date: 7 September 1988 (07.09.88)

(21) International Application Number: PCT/BR88/00003

(22) International Filing Date: 11 February 1988 (11.02.88)

(31) Priority Application Numbers: PI 8700856
PI 8706969

(32) Priority Dates: 24 February 1987 (24.02.87)
21 December 1987 (21.12.87)

(33) Priority Country: BR

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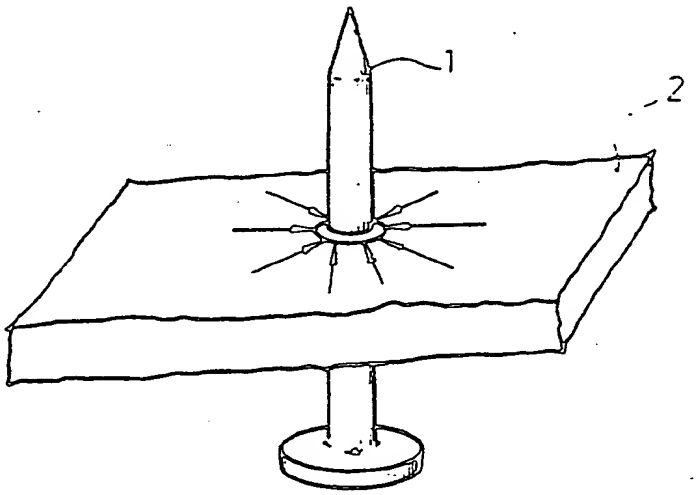
(81) Designated States: AT, AT (European patent), AU, BB, BE (European patent), BG, BR, CH, CH (European patent), DE, DE (European patent), DK, FI, FR (European patent), GB, GB (European patent), HU, IT (European patent), JP, KP, KR, LK, LU, LU (European patent), MC, MG, MW, NL, NL (European patent), NO, RO, SD, SE, SE (European patent), SU, US.

Published
With international search report.

(54) Title: IMPERVIOUS TYRE OR CONTAINER FOR HOLDING A FLUID



(57) Abstract

A container for holding a fluid is described, which has self-sealing characteristics in case of puncture. The container of the invention comprises at least one layer precompressed or not (2, 5, 8, 11, 13) adjacent to or integral with a wall of the container (3, 7, 9, 10, 12, 14), the molecules of said layer being compressible against one another in all directions when there is a differential of pressure between the inside and the outside of the container. The teachings of the invention are also described when applied to a tyre for vehicles, an inner tube for a tyre and a substrate applicable to at least one wall of a container. This substrate comprises at least one layer precompressed or not (16), the molecules of which are compressible against one another in all directions when said pressure is applied to the container, inner tube, chamber or casing. This substrate (S) can be comprised of a foam material base (15) impregnated, for example, with a silicone-jelly (16).

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Impervious tyre or container for holding a fluid.

The present invention refers to a tyre, an inner tube or a liner for a vehicle tyre, as well as to any container for holding fluids under a certain pressure.

Conventional inner tubes for tyres, for example, are normally made either of natural rubber or of vulcanized synthetic rubber and are placed inside the tyre and around the wheel.

However, when the inner tube is inflated, the rubber is placed under considerable tension whereby, in the event of penetration of a nail or other sharp object into the tyre, the surface of the inner tube presents an initial resistance to penetration after which it gives way, and the nail perforates it. The high tension existing at the moment of perforation acts in a negative manner, since it causes the puncture to have an area larger than that of the cross-section of the nail that pierces the rubber. This effect is comparable, in a smaller scale, to what happens to a rubber balloon that bursts when perforated, namely, the high tension causes spreading of the failure that was initially limited to an orifice, thus causing collapse of the whole structure.

The obvious consequence of the puncture being larger than the nail is the leakage of air which is pressurized within the inner tube.

Conventional tubeless tyres admittedly have a better capacity of being punctured by sharp objects such as nails without there being any major leakage of air, as is the case

with tyres provided with inner tubes. However, even these tyres present leakage to a certain degree, when punctured.

One object of the present invention is to improve tubeless tyres with regard to their self-sealing capacity, in the event of a puncture.

Another object of the invention is to provide an inner tube or a liner for a vehicle tyre with excellent self-sealing properties in the event of a puncture.

A further object of the invention is to provide a chamber for holding a fluid with optimum self-sealing characteristics in the event of a perforation.

Such objects have been achieved, according to the invention, by a vehicle tyre comprising a layer made up of molecules compressed against each other, in all directions, at least when the tyre is pressurized. For example, at least one layer of precompressed material can be inserted into the tyre so as to extend around the latter, which layer is preferably inlaid into the material of the tyre itself, and arranged parallel to the tyre tread.

The inclusion of a layer of a precompressed material in the tyre substantially improves the self-sealing capacity thereof, since when, for instance, a nail penetrates it, the material of this layer exerts pressure against the surface of the nail by virtue of the precompression which it received. This precompression continues to act even after the nail has been removed, so that the bore will be automatically sealed.

As regards independent inner tubes used in tyres, the present invention is based on the same principle which has been indicated as a solution for tyres, that is, the tube should be made up in such a manner that, when in use, it will have at least one layer in a compressed state, i.e., unlike the present practice, the inner tube should be prevented from stretching in order to fill the whole hollow space inside the tyre. Thus, instead of the material of the tube being under tension, thus causing the immediate expansion of any orifice made by a perforating object, the inner tube material or at least a layer thereof is compressed in all directions, sealingly acting around an object that by chance penetrates the inner tube.

The same inventive concept is also applicable to a container made of any material and intended to contain a fluid under a certain pressure. For example, the invention may be applied to a metallic tank designed for containing any liquid or gaseous fluid, or even to any chamber or container intended to work under a negative pressure.

A series of embodiments may be derived from this basic conecpt.

A first solution consists in that, in the relaxed or non-operative state, the linear dimensions of the inner tube are substantially equal to or larger than those of the internal space that it will occupy in the tyre, so that, when a suitable pressure is applied to the inner tube already inserted into the tyre, there will be no expansion of the tube. According to this solution, there will be no stretching of the material of the inner tube, due to inflation, which, is in reality the main cause of leakage of air when the tube is punctured. Instead, there will be a compression of the tube against the inner wall of the tyre.

A second solution is that the inner tube is internally or externally coated, at least in the region corresponding to the tread of the tyre, with a layer of a material that is softer and more compressible than that of the inner tube itself. By means of this solution it is possible to make the pressure exerted by the inner tube itself on the layer of softer material against the inner surface of the tyre (in the case of an external coating) bring about the compression of the layer in such a manner that it will act sealingly, if penetrated by a perforating object. In the case of an internal coating, the air itself contained in the inflated inner tube will compress the layer of softer material against the inner surface of the tube, thus causing the same effect as just mentioned.

A third embodiment consists in providing the inner tube, internally or externally, with a layer of precompressed material, at least in the region corresponding to the tread of the tyre. This layer can consist, for example, of the material of the tube itself, and one of the manners of applying it consists in inflating the inner tube (before insertion into the tyre), thereby causing it to reach a volume greater than the

internal volume of the tyre in which it will be used, and then applying said layer on the outside of the inflated air-tube by gluing or any similar method. Therefore, when this outer layer resumes a more reduced volume, it will be precompressed or some what wrinkled, so that its molecules will always tend to be compressed against the surface of some object that perforates the tube, when in use, thus causing the sealing effect.

A fourth embodiment consists in that the surface of the inner tube, at least in the region corresponding to the tread of the tyre, is formed with corrugations. Thus, when the tube is inflated inside the tyre, the corrugated region will be compressed against the inner surface of the tyre, so that the corrugations will tend to change into a smooth surface, but will the creation of a compression in its own plane. This compression will act in the way already explained in the preceeding embodiments.

All of the above-mentioned embodiments for a closed inner tube equally apply to novel tyre liners for lining tyres internally at least in the region corresponding to the tread.

However, the inventive concept also applies to any kind of chamber or liner designed for holding a fluid, as for example, an inflatable boat, a buoy or the like, the self-sealing effect being achieved by the fact that the chamber or liner comprises at least one layer supported by the structure of the chamber of liner, between the outside and the inside thereof, will have its molecules compressed against one another in all directions.

According to the invention, the layer referred to above may consist of silicone. It is possible, for instance, to apply a silicone layer to the inner or outer surface of a conventional rubber inner tube. Since silicone is a material with a greater capacity of absorbing the effects of compression, it offers little resistance to the penetration of sharp objects, for which reason, even if a nail, for example, punctures the tyre and inner tube, there will be no leakage of air, for the silicone of the air-tube under the action of the pressure of the air contained therein will accomodate itself around the nail in the perforated region, thus acting as a seal against any leakage, even after removal of the nail.

This effect is especially notable in an embodiment of the invention according to which the inner tube is wholly made of silicone.

Experiments have shown that, even if the sharp object is introduced and removed several times in the silicone inner tube at the same place, the material tends to close again, thus blocking the outflow of air. In this way a virtually puncture proof inner tube is obtained.

Even if major damage is caused to the inner tube, in such a way that the material itself can no longer be reconstituted, the silicone can be easily repaired by applying a silicone paste from a tube to the damaged area, the paste combining with the inner tube material, ensuring a very reliable repair.

Another embodiment of the present invention consists in that the inner tube need not be equipped with a valve. An inner tube of this type is especially suitable for racing cars and can be inflated by means of a needle, by virtue of the fact that the orifice made by the needle will automatically close when the latter is removed.

In the cases in which the silicone is applied only to the outer surface of the inner tube, a silicone resin can be used, whereas in the cases in which the inner tube is wholly made of silicone, either a silicone elastomer or a rubber can be used.

A tyre coated internally with silicone is especially suitable for use as tubeless type, since in this case, if the tyre is punctured, the silicone layer on the tyre itself will seal the puncture.

Experiments with a silicone inner tube having a wall thickness of 8mm have shown that even the penetration of 38-caliber bullets discharged by a firearm will not annul the capacity of the material to reconstitute itself and seal the puncture caused thereon. This shows the suitability of silicone inner tubes for military wheeled vehicles as well, which, at present, are provided with a complex compressor system connected to the tyres, in order to maintain the pressure therein, in case of a puncture. With the application of the present invention, such compressor system could even be eliminated.

The invention will now be described in more detail on the basis of the embodiments shown in the accompanying drawings, as follows:

figure 1 shows the behaviour of a precompressed layer around a perforating object;

figures 2a and 2b show a partial cross-section view taken along an axial plane of a first embodiment of the invention for a tubeless tyre;

figure 3 is a partial cross-section view taken along an axial plane of a second embodiment of the invention for a tubelesstyre;

figure 4 is a cross-section view taken along a radial plane of a first embodiment for an inner tube;

figure 5 is a partial cross-section view taken along an axial plane of another embodiment for an inner tube;

figure 6 is a partial cross-section view taken along an axial plane of another embodiment for an inner tube;

figure 7 is a partial cross-section view taken along a radial plane of an embodiment for a tyre liner for a tubeless tyre; and

figure 8 is a schematic cross-section view of a substrate or liner according to another embodiment of the invention.

Figure 1 schematically illustrates the distribution of tension around a perforating object, for example a nail 1, which penetrates a layer 2 of a precompressed material. Since the molecules of layer 2 are precompressed, the material tends to compress itself against the surface of an object that perforates such a layer, and therefore to function in a sealing manner. Thus, a tyre equipped either with a precompressed layer or with an inner tube or a liner that acts in a similar manner, will not leak when it is punctured. Even when the perforating object is removed, the precompression will act in such a way that the material will once more resume its original form, thereby automatically sealing the resulting puncture, and it can also reconstitute the material completely when the material applied has reconstitution characteristics, such as, for example, when the material is somewhat gelatinous or pasty and its molecules can reassemble due to the mere effect of

compression.

An embodiment of the invention according to figures 2a and 2b consists in equipping a tubeless tyre 3 with an intermediate layer 5, which when finished (figure 2b) is pre-compressed. This can be achieved, for instance, by the application of an intermediate corrugated layer 5 between the base layer 4 and an inner layer 6. Thus, the precompression effect is achieved by the fact that the intermediate layer 5 has a larger surface than that intended to receive it so that in the finished state such layer will be "squeezed" between the layers that surround it.

Figure 3 illustrates an alternative embodiment in which a layer 8 of a softer compressible material is internally applied to the material of a tubeless tyre 7, so that the internal pressure in the tyre will be sufficient to compress it. The internal pressure of the tyre 7 acts so as to compress the layer 8 against the inner wall of the tyre 7, so that the penetration of a perforating object will cause reactions of the type illustrated in figure 1.

A first embodiment of an inner tube 9, as illustrated in figure 4, consists in that, in the relaxed or tension-free condition, the inner tube has a shape and dimensions adjusted to the internal shape and dimensions of the tyre for which it is designed. This aims at preventing the inner tube from being stretched inside the type, as usually happens, because the volume in the relaxed state of known inner tubes is smaller than the internal volume of the tyres. Thus, instead of the occurrence of the known tension forces, which are unfavourable in the case of damage to the inner tube, the tube according to the present invention will accomodate itself inside the tyre without its material being under tension. This inner tube can consist of a soft rubber and may be made of silicone.

A further possible embodiment, as far as the manufacture of a tyre comprising the teachings of the present invention is concerned, would be the precompression of at least a part of a tyre during the manufacture thereof, so that, on leaving the vulcanizing press, it will already have incorporated therein at least one layer integral with the tyre itself, which should be in the precompressed state when the tyre is not

pressurized. Accordingly, in this case, even when the tyre is pressurized the said precompressed part thereof will remain precompressed, therefore acting similarly to the said layer 8 described above in its compressed state.

Figure 5 shows an alternative for the manufacture of an inner tube in which a layer 11 of a precompressed material or a softer material is applied outwardly to the material of a conventional inner tube 10. Naturally, the order of the layers illustrated may be reversed, that is, layer 11 could be applied inside the inner tube 10 prior to its final vulcanization.

Figure 6 illustrates an embodiment in which at least the inner tube wall 12, which bears against the inner wall of the tyre, is corrugated. This has the effect that, in pressurizing the inner tube, the recesses of the corrugations are flattened against the inner wall of the tyre, whereby a precompression between the molecules of the inner tube is created.

Figure 7 shows a tyre inner 13 applied inside tubeless tyre 14 so as to line the tyre only partially. This liner 13 should be made of a softer material, for example, silicone, and/or of a corrugated material or, moreover, its shape can be adjusted to the inner volume of the tyre 14 or can be composed in a way similar to that illustrated and described with respect to figure 5. In short, the same alternatives suggested for an integral inner tube may be applied to a tyre liner.

In all of the proposed alternatives there is the basic idea of providing a layer whose molecules, during use of the tyre or the inner tube or the liner, are compressed against one another in all directions, so as to act in a sealing manner at the moment of penetration by a perforating object, apart from closing the puncture again after such an object has been removed, thereby avoiding a drop in the internal pressure of the tyre.

According to a further embodiment of the teachings of the present invention, illustrated in figure 8, a substrate S is provided, which is applicable to the wall of a container, chamber or casing designed for holding a fluid under pressure, the substrate consisting of a base layer 15 made of a foam material impregnated with a silicone jelly 16.

A substrate similar to that described above

with reference to figure 8 can be applied, for instance, to the inner walls of a tubeless tyre, and will then function as the layer 8 described with reference to figure 3. It is also obvious that such a substrate S can be applied to any container whatever, for example, a metallic tank designed for holding any fluid under a given pressure, be it a liquid or a gas.

Although the above-described examples of embodiments of the invention mention silicone as the material of which the layer is made, it should be understood that any suitable material can be used in carrying out the invention, provided that it has the physical properties of easy compressibility, elasticity or flowability, as well as the capacity of withstanding perforations. Equally one may use gelatinous materials that have a behaviour similar to that of a high-viscosity fluid, when subjected to pressure. Examples of such materials would be the following: materials based on butyl, latex, polyurethane, polyurethane gelatine and synthetic or natural elastomers.

Of course, the inventive principle may be applied to any type of layer that holds or isolates any fluid whatever.

It should also be understood that the teachings of the invention can be applied to any type of product where there is a chamber or container under pressure. Thus, besides vehicle tyres, the invention can be applied, for example, to lifeboats, buoys, gas reservoirs, hoses or conduits working under pressure and balloons.

CLAIMS:

1. A container for holding a fluid, characterized in that it comprises at least one layer (2,5,8,11,13) adjacent to or integral with one wall of the container (3,7,9,10,12,14) the molecules of said layer becoming compressed against one another in all directions at least when there is a differential of pressure between the inside and the outside of the container.

2. A container according to claim 1, characterized in that said layer (2,5,8,13) is provided adjacent to at least one inner wall of the container (3,7).

3. A container according to claim 1, characterized in that said layer (5) is integral with at least one wall of the container (3).

4. A container according to claim 1, characterized in that said layer (11) is provided adjacent to at least one outer wall of the container (10).

5. A container according to any one of the preceeding claims, characterized in that said layer (2,5,8,11,13) is made of a polymeric material.

6. A container according to claim 5, characterized in that said polymeric material is silicone.

7. A container according to claim 1, characterized in that said layer (5) is constituted by a corrugated material when in a relaxed state.

8. A tyre for a vehicle, characterized by comprising at least one layer (5,8,11) adjacent to or integral with at least a portion of the inner wall of the tyre (3,7,14), the molecules of said layer being compressed against one another in all directions when the tyre is pressurized.

9. A tyre according to claim 8, characterized in that said layer (5,8,13) is provided adjacent to an inner wall of the tyre (3,7,14).

10. A tyre according to claim 8, characterized in that said layer (5,8,13) is integral with at least one wall of the tyre (3,7,14).

11. A tyre according to claim 10, characterized in that said layer (5) is built into the material of the tyre (3) in a precompressed condition.

12. A tyre according to any one of claims 8 through

11, characterized in that said layer (13) is placed in the region corresponding to the tread (14) of the tyre.

13. A tyre according to any one of claims 8 through 12, characterized in that said layer (5,8,13) is made of a softer material than the material of the tyre (3,7,14).

14. A tyre according to claim 13, characterized in that said material is a polymeric material.

15. A tyre according to claim 14, characterized in that said material is silicone.

16. A tyre according to claim 8, characterized in that the layer (5) is constituted by a corrugated material when in the relaxed state.

17. Tyre for a vehicle characterized in that it comprises at least a portion thereof in a precompressed state.

18. An inner tube (9) for a tyre, characterized by being wholly formed of silicone.

19. A substrate (S) applicable to at least one wall of a container, chamber or casing designed for holding a fluid under a given pressure, characterized by comprising at least one layer (16), the molecules of said layer being compressible against one another in all directions when said pressure is applied to the container, chamber or casing.

20. A substrate (S) according to claim 19, characterized by comprising a foam material base (15) impregnated with silicone (16).

FIG. 1

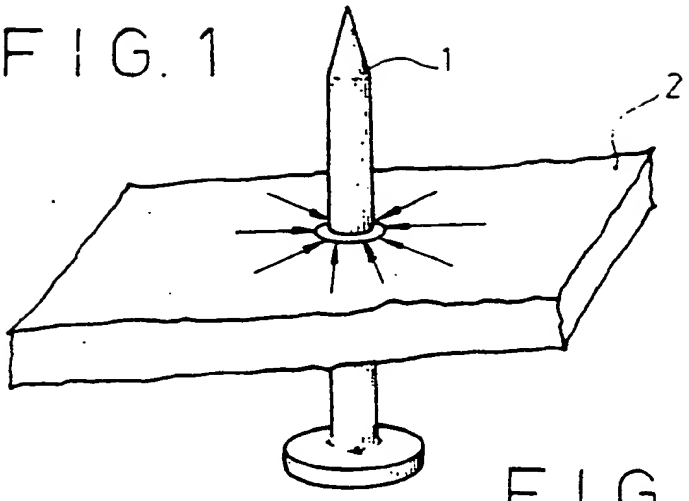


FIG. 2a

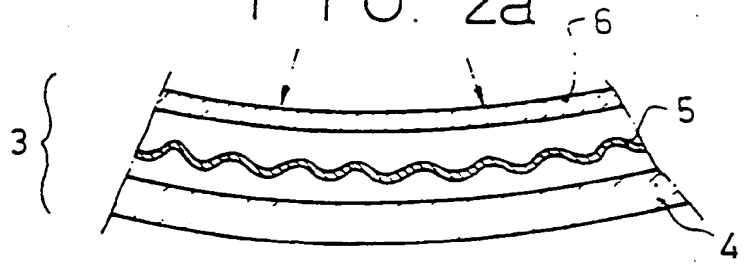


FIG. 2b

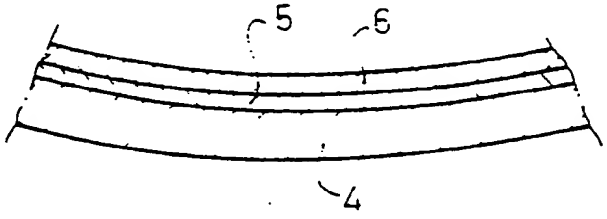
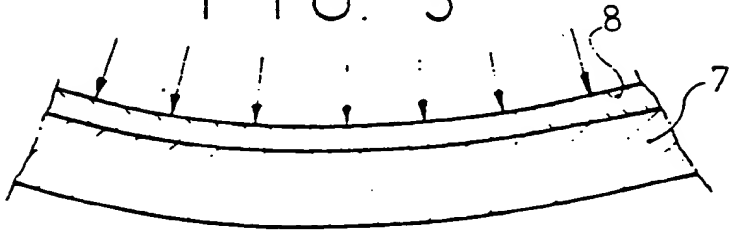


FIG. 3



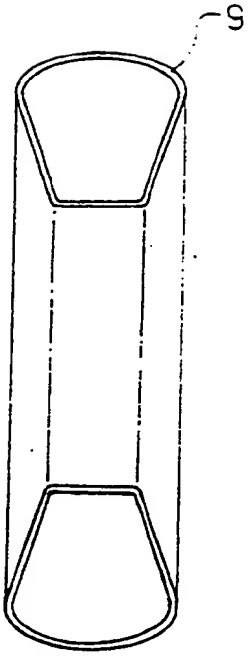


FIG. 4

FIG. 5

FIG. 6

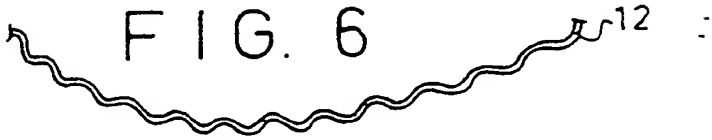


FIG. 7

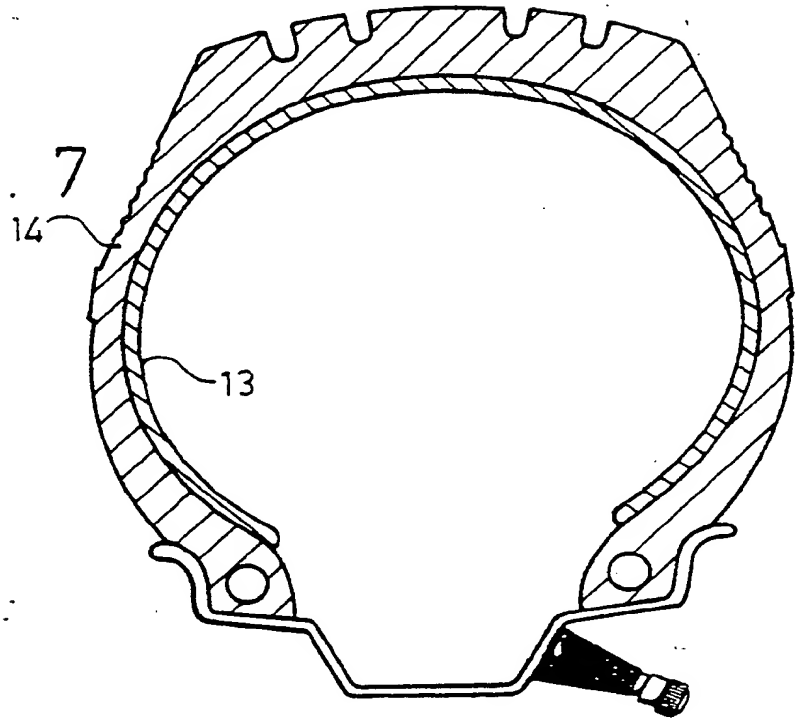
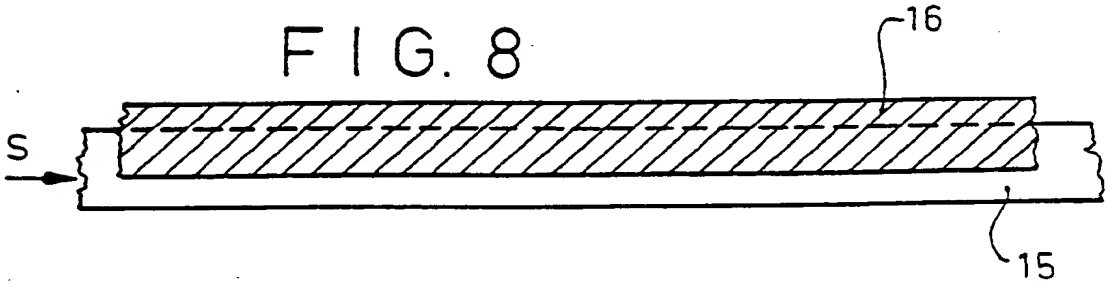


FIG. 8



INTERNATIONAL SEARCH REPORT

International Application No PCT/BR 88/00003

I. CLASSIFICATI N OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[4]: B 60 C 21/10

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC[4]	B 60 C 21/10

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X	DE, C, 645109 (M. RÜGER) 29 April 1937 see page 1, lines 1-65; figure 1	1,2,4,5, 8,9,12-14,19,20
X	BE, A, 498387 (AUTO-OBTURATEUR) 15 January 1951 see page 1, lines 15-18; page 4, line 11 - page 5, line 24	1-5,8-11, 14,17,19, 20
A	FR, A, 2232456 (GOODYEAR) 28 May 1974 see the whole document	1-5,8-11
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IV. CERTIFICATI N

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
11th May 1988	13 JUN 1988
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	P.C.G. VAN DER PUTTEN

Form PCT/ISA/210 (second sheet) (January 1985)

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. BR 8800003 SA 20889

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE-C- 645109		None	
BE-A- 498387		None	
FR-A- 2232456	03-01-75	NL-A- 7407693	10-12-74
		BE-A- 815757	16-09-74
		DE-A- 2427452	02-01-75
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